

Name: _____

EXERCISE 2: DIGITAL IMAGES
Due Tuesday, 17 February 2009

I. INTRODUCTION

In this lab we'll begin exploring digital images with IDL. Digital detectors, which are placed at the focal plane of a camera or telescope, are two-dimensional arrays composed of up to millions of separate light-sensitive elements. The elements are tiny squares of semi-conducting material, often silicon, called **pixels**. An individual pixel will release an electron from its molecular bond when it is hit by a photon according to the photoelectric effect. Brighter light (more photons) will release more electrons, which are then counted by the detector's readout electronics. The digital image thus consists of a 2-dimensional array of numbers consisting of spatial (x,y) pairs and an intensity, usually consisting of the number of electrons counted converted to a unitless number called "Data Number" (DN), "counts" or "analog-digital units" (ADUs).

II. SLOAN DIGITAL SKY SURVEY

The digital images you will explore here are taken from the archives of the Sloan Digital Sky Survey (<http://www.sdss.org/>). SDSS makes images on 25 CCDs through five different color filters, listed in Table 1. The different images allow us to measure important characteristics of stars and galaxies such as their temperature, composition, mass, distance, and age.

Filter	<i>u</i> (ultraviolet)	<i>g</i> (green)	<i>r</i> (red)	<i>i</i> (infrared)	<i>z</i> (infrared)
Central wavelength	3543 Å	4770 Å	6231 Å	7625 Å	9134 Å
DR4 index number	1	2	3	4	5

We have downloaded from the SDSS Data Release 6 (DR6) a five-filter set of images of M3, a bright globular cluster.

III. EXPLORING MONOCHROMATIC DIGITAL IMAGES WITH IDL

- a. Login in to one of the class computers
- b. Start ast337idl (see cheatsheet)
- c. Make a subdirectory, and download the m3 images from the class website to your own directory

A. **Display** an image (IDL> atv, 'SDSSDR6m3.2.fits'), and explore ATV. Magnify (zoom) *until you can see individual pixels*. Try displaying directly from ATV using **File** → **ReadFits**.

B. Examine the *FITS header* from within ATV using **ImageInfo** → **ImageHeader**. Find the following:

1. The number of rows and columns in the image (in pixels). Each pixel is a square with a length of 0.396 arcseconds. What is the *field of view* of the image in arcseconds?
2. Right ascension (RA) and declination (DEC) of the image, and the epoch of those coordinates (search for “equinox”).
3. The date the image was taken.

C. **ImExam**

1. Explore the image in ATV and using the **ImExam MouseMode**. Which location in the image is column = x = 0, row = y = 0? Which is x=500, y=1000? (Show these in a sketch.)
2. Explore the **r** and **c** keystrokes. Explain what these plots are.
3. Explore the **h** keystroke. What is this plot showing? What part of the image do you suppose the peak of the histogram corresponds to? Use this tool to measure the typical brightness of the background sky in the image.
4. Under **ImageInfo**, explore the **Statistics** (also **i** keystroke) and **PixelTable** features. Use them to study one of the brightest stars in the image. What is its position and peak brightness *above the sky background level* (i.e., the difference between mean background and star peak)?

5. Move to an isolated star and locate the cursor on it. Explore the **s** and **t** keystrokes. Describe them in a few sentences.

6. Use the **ImageInfo** → **Photometry** (also **p** keystroke) feature to measure the star's centroid and maximum brightness (**Z** peak).

7. What is a typical peak brightness *above the sky background level* for one of the faintest stars visible in the image?

8. Center your image and save that view using **Blink** → **SetBlink1**. Then display a different image (i.e., different wavelength) of the same M3 field. Switch the MouseMode to Blink and use the left mouse button to switch back and forth between the two frames. What differences do you notice?